Higher temperature at Honolulu.—The north equatorial current flows from east to west in the latitude of the Hawaiian Islands. If the wind which causes this current has changed from northeast to east in the region of Hawaii and thence eastward, of which there is no evidence at hand as to how far to the eastward of Honolulu the change extended, then there should be a slight rise in the temperature of the surface water flowing by Honolulu and consequently higher temperature at Honolulu.

The average annual mean temperature of Honolulu, 1905–1909, is 74.2° and for 1920–1924, 75.0° or 0.8° higher during the last five-year period as compared with the first. Meteorological changes may be due to several factors, and it will require further information before the most probable cause of the higher temperature can be segregated.

Effect of cold upwelling water.—The temperature of the ocean surface water west of the California coast is relatively low owing to the upwelling of abysmal waters. McEwen claims that the effect of this upwelling extends to a distance of 300 kilometers (373 miles) from the coast at Mendocino, in N. lat. 40°, and to a distance of 2,100 kilometers (1,305 miles) off the coast at San Diego. In a personal communication Doctor McEwen informed the writer that "This upwelling is a local phenomenon, dependent upon the Pacific HIGH, although the source of the upwelling water is probably Antarctic. This supply probably slowly drifts northward from the Antarctic along the bottom as needed to supply the deficiency of water due to surface flow away from the California coast by the winds about the North Pacific HIGH.

As previously shown (see fig. 3), the geographic position of the North Pacific anticyclone has a regular seasonal meander, being nearest the California coast in winter and farthest away in summer. So far as known there is no direct relation between the upwelling and the annual migration of the anticyclone. One would expect that the least upwelling along the California coast and naturally the warmest surface water would be experienced in late summer, when the anticyclone had reached its farthest northing.

Ocean surface-water temperatures would be helpful in determining whether the rise in temperature at Honolulu is properly chargeable to increased surface-water temperature.

In this section records of the prevailing wind direction on certain islands of the Pacific in the region of the trades have been presented rather fully. These show good agreement with like records obtained from ships at sea; they show, moreover, for Honolulu and Hilo at least, that there have been slow but progressive slight changes in the general direction of the trades, viz, that the easterly component in these winds has increased, particularly in the later years of the record.

The true explanation of this increase is not at once apparent. It may have been due, as postulated in the discussion, to a change in the average pressure distribution whereby the locus of maximum daily and monthly mean pressure has shifted to a more easterly point on the ocean, or it may have been due to local land-surface obstructions which at present can not be delimited.

CHAPTER III

AVERAGE VELOCITY OF NORTH PACIFIC TRADES

According to the Pilot Charts, the average velocity of the North Pacific trades is force 4 on Beaufort scale, which is equivalent to about 20 miles per hour. In winter and spring there are quite a number of squares on the Pilot Charts having force 5 Beaufort, about 25 miles per hour. Only on three of the squares is a force as high as 6 recorded. Force 6 is equivalent to about 31 miles per hour and it occurs once in April and twice in November. The one case in April and one of the two cases in November are located in the extreme east portion of the trade-wind belt, and the other one in November is located at the western extremity or in the northeast monsoon area of the Asiatic coast.

Increase in velocity toward the Equator.—Milham in writing about the trades states, "As they approach the Equator the velocity steadily increases." This of course does not apply to the western portion of the North Pacific trade-wind belt, as the winds in that region are of monsoon character, having their cause in the Asiatic winter anticyclone. They blow across the Equator and in the midwinter extend as far as Australia. In the true North Pacific trade-wind belt there is a slight tendency for winds to increase in velocity on approaching the Equator, but it is not well defined, probably because of lack of exactness in the record.

While the Weather Bureau station at Honolulu is not advantageously situated as regards the measurement of the true speed of the northeast trades in that part of the Pacific, yet the record has its value and is presented in Tables 10 and 11, the first giving the total travel from all directions and the second from the northeast and east, the trades only.

TABLE 10.—*Total monthly and annual wind movement in miles at Honolulu, Hawaii, period 1905–1924, inclusive*

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
1905	6,050	4,406	6,302	7,213	6,667	6,211	6,522	6,653	6,400	6,481	5,522	6,070	74,503
1906	7,248	5,212	6,796	6,187	6,633	6,012	6,528	6,577	5,898	5,913	5,376	8,112	76,492
1907	5,626	5,910	7,925	6,982	5,578	5,588	6,422	6,766	5,354	6,065	6,822	5,060	74,096
1908	6,422	5,291	5,332	7,374	6,530	6,452	6,210	5,994	5,741	5,379	5,656	7,666	74,047
1909	6,956	6,216	8,229	5,466	6,535	6,423	6,825	6,537	5,974	6,047	4,870	6,136	76,214
1910	7,322	4,752	6,324	6,699	6,363	6,434	6,210	6,319	4,052	5,362	5,804	6,072	71,713
1911	7,510	6,379	4,734	5,970	5,944	6,440	6,547	5,736	6,092	5,116	6,438	6,301	73,207
1912	5,511	5,955	6,404	7,174	6,460	5,808	5,151	6,125	5,351	6,186	6,003	6,373	72,501
1913	5,192	5,422	5,952	8,247	5,154	5,798	5,983	5,929	5,300	4,259	7,269	5,346	69,851
1914	7,308	3,644	5,752	6,405	6,680	6,443	6,615	7,405	6,840	6,148	6,042	5,268	74,550
1915	6,620	6,255	5,630	6,084	5,276	5,935	5,800	6,443	5,446	6,950	6,687	6,187	72,813
1916	6,648	5,008	7,473	6,431	7,270	6,902	6,110	6,086	5,500	5,440	6,294	6,820	75,982
1917	6,049	5,323	5,694	5,496	4,761	5,399	6,211	5,806	5,588	4,594	5,369	5,644	65,934
1918	5,600	6,214	5,949	7,121	6,046	6,286	7,048	6,172	5,281	6,491	6,767	8,092	77,067
1919	5,860	6,452	6,884	5,351	6,272	5,146	6,356	6,413	6,198	5,541	4,609	5,472	70,554
1920	5,502	5,194	5,657	6,039	4,521	6,377	5,956	6,339	6,309	5,856	5,827	7,063	70,640
1921	8,063	4,664	6,019	7,548	4,565	6,116	6,721	5,893	6,718	5,278	6,317	6,355	74,257
1922	6,821	6,208	6,344	6,330	6,575	5,009	6,662	6,128	5,969	5,058	5,355	4,272	70,831
1923	7,437	3,827	6,191	6,603	6,751	6,662	6,864	5,964	5,385	5,736	6,065	6,380	73,865
1924	5,096	5,089	5,997	4,929	5,122	5,043	6,647	6,740	6,062	6,304	5,315	6,211	67,555
Means	6,442	5,376	6,279	6,482	5,985	6,024	6,369	6,301	5,773	5,710	5,920	6,195	72,859

[1] Velocities reduced to the old elevation from May 1, 1922, to December, 1924, inclusive.

TABLE 11.—*Total monthly and annual movement in miles for northeast and east winds only, at Honolulu, Hawaii, period 1905–1925, inclusive*

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
1905	3,094	2,308	4,276	6,770	6,307	5,864	5,904	6,571	5,908	6,042	4,361	5,221	62,626
1906	2,926	2,675	2,718	5,244	5,996	5,204	6,463	6,487	5,763	5,349	4,259	4,981	58,067
1907	1,489	3,821	7,171	6,019	3,842	5,098	6,091	6,597	4,557	5,441	6,082	4,302	60,510
1908	5,531	4,040	2,494	6,888	6,376	6,445	6,155	5,701	5,529	4,902	4,915	7,504	66,480
1909	4,480	4,785	7,590	3,919	6,126	6,316	6,614	6,469	5,632	5,277	4,028	3,589	64,825
1910	6,747	3,246	5,708	6,522	5,679	6,333	5,989	6,077	2,575	4,696	5,186	4,567	63,325
1911	4,556	4,620	2,368	5,025	5,563	6,394	6,358	5,523	6,001	4,225	6,136	5,926	62,695
1912	1,920	3,730	5,734	7,067	6,171	5,374	5,034	5,659	4,959	6,115	5,756	6,008	63,527
1913	3,246	2,719	4,887	8,138	3,954	5,221	5,736	4,989	4,734	2,757	6,625	3,780	56,786
1914	5,193	1,627	2,598	4,161	6,033	6,329	6,445	7,274	6,646	5,781	5,140	3,060	60,287
1915	3,966	5,953	3,213	4,894	3,899	5,450	5,702	6,213	5,236	6,818	6,025	4,054	61,423
1916	2,290	3,005	5,380	5,446	7,058	6,763	6,012	5,852	5,232	4,263	6,101	6,011	63,413
1917	3,585	1,360	4,368	4,605	3,716	5,274	6,151	5,690	5,234	3,586	4,542	2,555	50,666
1918	3,185	4,470	5,226	6,074	5,343	5,737	6,979	5,914	4,672	5,992	5,265	7,736	66,593
1919	4,658	5,891	5,270	4,731	5,750	4,772	6,312	6,227	5,404	4,709	3,511	2,882	60,117
1920	1,459	4,649	4,688	4,646	2,148	6,109	5,770	6,229	6,280	5,467	5,610	5,286	58,341
1921	7,434	2,349	4,620	7,043	3,161	5,950	6,675	5,831	6,678	3,980	5,730	5,419	64,870
1922	6,106	5,758	5,425	5,680	6,393	4,568	6,392	6,047	5,618	5,458	4,412	3,559	65,416
1923	5,996	1,745	4,717	5,325	6,240	6,531	6,831	5,626	5,183	5,357	5,714	4,730	63,995
1924	3,625	3,899	5,075	3,380	4,614	4,719	6,606	6,632	6,044	6,154	4,061	2,082	56,913
1925	5,578	2,582	6,141	7,068	6,310	6,438	5,163	7,000	5,005	3,218	5,817	1,413	61,731
Means	4,146	3,582	4,746	5,650	5,270	5,757	6,161	6,124	5,376	5,028	5,205	4,508	61,563

[1] Velocities reduced to the old elevation from May 1, 1922, to December, 1925, inclusive.

The above tables show that there were two 12-month periods of large wind travel, the second of which was preceded by one of small wind movement, thus illustrating a rule of nature that one extreme is quite generally followed by another in the opposite direction. These three periods are segregated in the exhibit below.

Periods	Total, all directions	Per cent of average	Northeast and east only	Per cent
12 months ending—	*Miles*		*Miles*	
October, 1909	78,530	108	71,270	111
March, 1919	78,500	108	69,531	113
January, 1918	65,485	90	50,266	82

Without attempting to assign a cause for the pronounced decrease in wind travel of 1917–18 as compared with other years, it should be recalled that total wind movement the world over is known to vary from year to year and to a degree commensurate with that shown above. The annual wind travel at Eureka, Calif., in the 15 years, 1911–1925, with the same exposure of the wind instruments throughout the period, varied from a maximum of 107 per cent to a minimum of 88 per cent. San Francisco for the same years varied from a maximum of 121 per cent to a minimum of 89 per cent. The year 1917 on the Pacific coast was one of generally small wind travel. Unfortunately data of wind force or travel over the ocean are not available, although the opinion is ventured that there also the wind travel in 1917, as at Honolulu, was less than the average.

The significance of the decrease can not be evaluated, since the phenomenon is one of rather general occurrence. The one fact which stands out in this analysis is that both the increase and decrease are confined to the northeast trades.

On a previous page it was pointed out that the northeast trades are subject to periodical changes in speed, depending upon the passage eastward of anticyclones in the trade-wind belt. It is therefore an allowable inference to associate periods of large wind movement with either a greater number of anticyclones or of greater intensity in individual anticyclones.

The average wind travel at Honolulu, all directions, is 72,859 miles, that of the trades 61,553 miles, a difference of 11,306 miles. In years of large wind travel the difference is less than the average, and in the single year of small travel the difference was 3,911 miles greater than the average, which seems to indicate that the trades diminish more rapidly than winds from other directions and that when pressure distribution is favorable to an increase in the general winds the effect is most pronounced in the trades.

THE WIND MOVEMENT, BY SEASONS

Below is presented the total wind movement in miles per hour for each season for all directions and also for the trades separately. The average velocity in miles per hour has been added. This average was obtained by dividing the average movement by the number of hours in the season, neglecting the small differences that would arise from considering leap years.

Wind movement in miles, all directions—Trades separately

	Spring	Summer	Autumn	Winter
All directions	18,746	18,694	17,403	18,013
Average miles per hour	8.5	8.5	8.0	8.1
Trades	15,666	18,042	15,609	12,236
Average miles per hour	7.1	8.1	7.6	5.7
Winds other than trades	3,080	652	1,794	5,777

The mileage, by seasons, for all directions shows great uniformity, autumn being slightly below the others. Considering the trades separately, however, it is seen that summer is preeminently the season of greatest development of the trades, as elsewhere mentioned. If 10 be taken to represent summer, then the seasonal ratios are spring 9, summer 10, autumn 9, and winter 7.

Table 12 is presented to show the total movement of northeast and east winds for each month of the record, expressed as percentages. The figures 75 for January, 1905, signify that the trades for that month were but 75 per cent of the average for January. In like manner the figures for the annual movement for 1905, 102, indicate that the trades for that year were 102 per cent of the average for all years combined. Other details can be gleaned from the table as may be desired.

TABLE 12.—*Monthly and annual percentages of the total movement of the wind from the northeast and east at Honolulu, period 1905–1925*

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
1905	75	64	90	120	120	102	96	107	110	120	84	116	102
1906	71	75	57	93	114	90	105	106	107	106	82	110	94
1907	36	107	151	107	73	89	99	108	85	108	117	95	98
1908	133	112	53	122	121	112	100	93	103	97	94	166	108
1909	108	134	160	69	116	110	107	106	105	105	77	80	105
1910	163	91	120	115	108	110	97	99	48	90	100	101	103
1911	110	129	50	89	106	111	103	90	112	84	118	131	102
1912	46	104	121	125	117	93	82	92	92	122	111	133	103
1913	78	76	103	144	75	91	93	81	88	55	127	84	92
1914	125	45	55	74	113	110	105	119	124	115	99	68	98
1915	96	166	68	87	74	95	93	101	97	136	116	90	100
1916	55	84	113	96	134	117	98	96	97	85	117	133	101
1917	86	38	92	82	71	92	100	93	97	71	87	57	82
1918	77	125	110	108	101	100	113	97	87	119	101	172	108
1919	112	164	111	84	109	83	102	102	101	94	67	64	98
1920	35	130	99	82	41	106	94	102	111	109	108	117	95
1921	179	66	97	125	60	103	108	95	124	79	110	120	105
1922	147	161	114	1101	121	79	104	99	105	109	85	79	106
1923	145	49	99	94	118	113	119	92	96	107	110	105	104
1924	87	109	107	60	88	82	107	108	112	122	78	46	92
1925	135	72	129	125	120	112	84	114	93	64	112	31	100

[1] Reduced to old elevation from May 1, 1922, to Dec. 31, 1925, inclusive.

AVERAGE HOURLY WIND VELOCITY AT HONOLULU

The average hourly wind velocity at Honolulu for each month of the record, 1905–1924, is given in Table 13, and the same information for the trades is given in Table 14.

The information in the last named has been graphed and the result is presented in Figure 10.

TABLE 13.—*Average hourly wind velocity in miles per hour at Honolulu, Hawaii, period 1905–1924, inclusive*

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
1905	8.1	6.6	8.5	10.0	9.0	8.6	8.8	8.9	8.9	8.7	7.7	8.2	8.5
1906	9.7	7.8	9.1	8.6	8.9	8.4	8.8	8.8	8.2	7.9	7.5	10.9	8.7
1907	7.6	8.8	10.7	9.7	7.5	7.8	8.6	9.1	7.4	8.2	9.5	6.8	8.5
1908	8.6	7.6	7.2	10.2	8.8	9.0	8.3	8.1	8.0	7.2	7.9	10.3	8.4
1909	9.3	9.2	11.1	7.6	8.8	8.9	9.2	8.8	8.3	8.1	6.8	8.2	8.7
1910	9.8	7.1	8.5	9.3	8.6	8.9	8.3	8.5	5.6	7.2	8.1	8.2	8.2
1911	10.1	9.5	6.4	8.3	8.0	8.9	8.8	7.7	8.5	6.9	8.9	8.5	8.4
1912	7.4	8.6	8.6	10.0	8.7	8.1	6.9	8.2	7.4	8.3	8.3	8.6	8.3
1913	7.0	8.1	8.0	11.5	6.9	8.1	8.0	8.0	7.4	5.7	10.1	7.2	8.0
1914	9.8	5.4	7.7	8.9	9.0	8.9	8.9	10.0	9.5	8.3	8.4	7.1	8.5
1915	8.9	9.3	7.6	8.4	7.1	8.2	7.8	8.7	7.6	9.3	9.3	8.3	8.4
1916	8.9	7.2	10.0	8.9	9.8	9.6	8.2	8.2	7.6	7.3	8.7	9.2	8.6
1917	8.1	7.9	7.7	7.6	6.4	7.5	8.3	7.8	7.8	6.2	7.5	7.6	7.5
1918	7.5	9.2	8.0	9.9	8.1	8.7	9.5	8.3	7.3	8.7	9.4	10.9	8.8
1919	7.9	9.6	9.3	7.4	8.4	7.1	8.5	8.6	8.6	7.4	6.4	7.4	8.1
1920	7.4	7.5	7.6	8.4	6.1	8.9	8.0	8.5	8.8	7.9	8.1	9.5	8.1
1921	10.8	6.9	8.1	10.5	6.1	8.5	9.0	7.9	9.3	7.1	8.8	8.5	8.5
1922[1]	9.2	9.4	8.5	8.8	8.8	6.9	9.0	8.2	8.3	6.8	7.4	5.7	8.1
1193	10.0	5.7	8.3	9.1	9.1	9.2	9.2	8.0	7.5	7.7	8.5	8.5	8.4
1924	6.8	7.4	8.0	6.8	6.9	7.0	9.0	9.1	8.4	8.5	7.4	7.0	7.7
Average	8.6	7.9	8.4	9.0	8.0	8.4	8.6	8.5	8.0	7.7	8.2	8.3	8.3

[1] Reduced to old location from May, 1922, to December, 1924, inclusive; ratio 100 (old) to 117 (new).

(To face p. 221.)

FIG. 8.—Windward (northeast) side of Koolau Mountains looking toward Honolulu, on the other side of the range

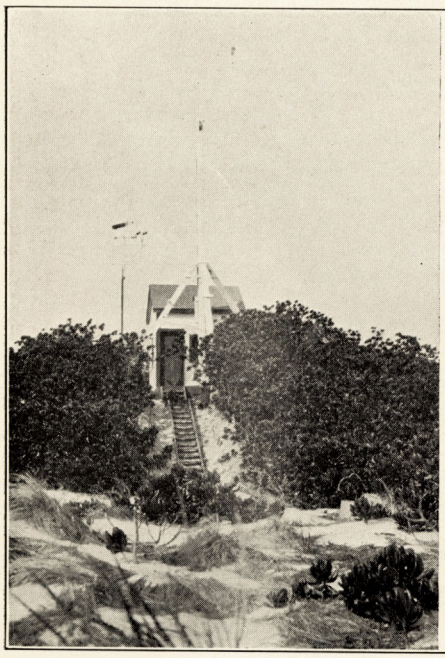

FIG. 12.—Wind-instrument exposure at Midway Island

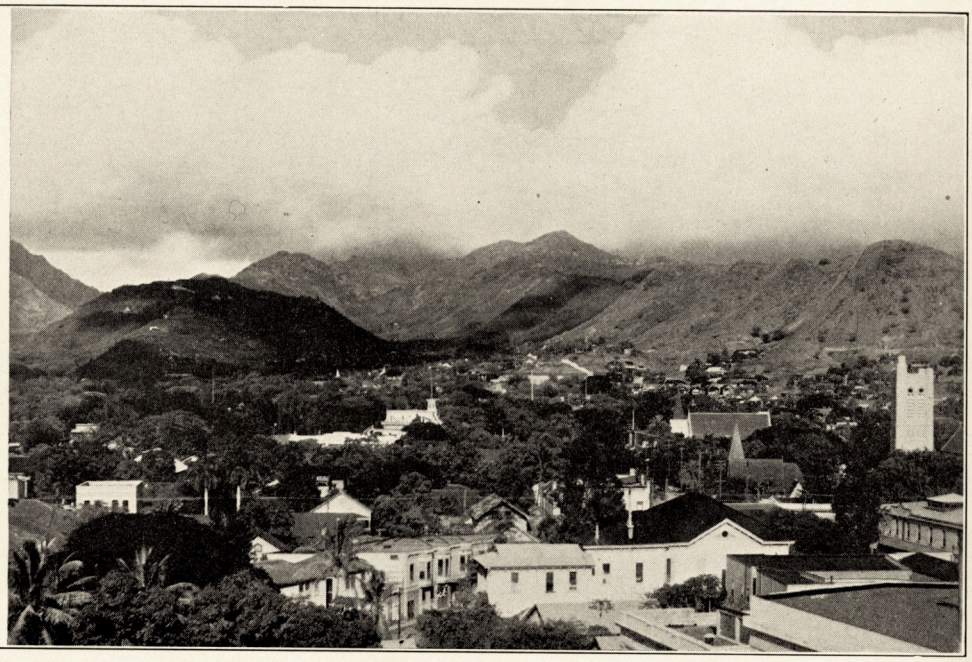

FIG. 9.—Looking east-northeast from Weather Bureau office in Honolulu

TABLE 14.—*Average hourly wind velocity in miles per hour for northeast and east winds only at Honolulu, Hawaii, period 1905–1925, inclusive*

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
1905	7.6	6.3	8.7	10.5	9.2	8.8	9.1	9.1	9.2	9.0	8.1	8.3	8.6
1906	8.0	7.4	8.6	8.9	9.2	8.4	8.9	8.9	8.3	8.3	7.7	10.2	8.7
1907	4.9	8.5	11.5	10.3	7.3	7.9	8.8	9.4	7.8	8.5	10.6	7.2	8.7
1908	9.3	8.1	6.9	10.7	9.0	9.0	8.5	8.3	8.2	7.7	8.2	10.6	8.8
1909	9.0	10.1	11.5	7.9	9.2	9.0	9.3	8.9	8.6	8.4	7.1	7.7	8.9
1910	10.2	7.7	8.7	9.4	8.8	9.2	8.5	8.9	5.6	7.6	8.5	8.6	8.6
1911	9.9	10.8	5.7	9.2	8.5	9.0	9.2	7.8	8.6	7.1	9.3	9.0	8.8
1912	5.9	8.9	8.8	10.1	8.9	8.3	7.1	8.4	7.5	8.4	8.7	9.0	8.4
1913	7.0	7.0	8.8	11.6	6.9	8.2	8.1	8.0	7.4	5.3	10.4	7.5	8.2
1914	10.3	4.7	6.9	8.5	9.7	9.1	9.3	10.3	10.1	8.5	8.9	7.1	8.9
1915	8.9	9.4	7.5	8.8	7.2	8.6	7.9	8.6	7.6	9.5	9.6	7.4	8.5
1916	7.3	7.0	9.9	9.2	10.1	9.8	8.4	8.4	7.8	7.2	8.9	9.9	8.8
1917	7.8	5.1	8.1	7.8	6.5	7.9	8.5	8.0	7.9	6.0	7.7	6.6	7.5
1918	7.3	9.3	9.1	10.8	8.7	9.1	9.7	8.6	7.4	8.9	9.8	11.1	9.2
1919	8.1	9.8	9.4	7.6	8.8	7.2	8.6	9.0	8.8	7.6	6.4	6.8	8.2
1920	4.9	7.7	8.3	8.3	5.0	9.4	8.3	8.7	8.8	8.1	8.5	8.9	8.1
1921	11.5	5.9	8.9	10.9	5.9	8.6	9.1	8.1	9.4	7.4	9.2	9.2	8.8
1922	10.0	9.8	8.9	9.4	[1] 9.1	7.1	9.3	8.3	8.7	8.9	8.1	5.9	8.6
1923	11.2	5.5	8.8	9.8	10.0	9.5	9.3	8.2	7.7	8.1	9.0	9.2	9.0
1924	7.9	8.1	8.9	7.6	7.2	7.4	9.0	9.2	8.5	8.8	8.0	6.4	8.2
1925	9.9	6.8	10.8	10.4	8.8	9.2	7.5	9.6	8.1	6.0	9.2	4.8	8.6
Av. m. p. h.	8.4	7.8	8.8	9.4	8.3	8.6	8.7	8.7	8.2	7.9	8.7	8.2	8.6
Av. m. p. s.	3.8	3.5	3.8	4.2	3.7	3.9	3.9	3.9	3.7	3.5	3.9	3.7	3.9

[1] Reduced to old location from May, 1922, to Dec. 31, 1925; ratio 100 (old) to 117 (new.)

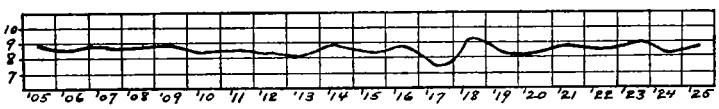

FIG. 10.—Average hourly velocity, northeast and east winds at Honolulu

The outstanding feature of Figure 10 is the steadiness of the trades, barring the years 1917 and 1918, when the largest oscillation in the 20 years occurred.

In winter the trades are more or less suppressed at times, and accordingly winds from other directions have the greater velocity.

In general the uniformity of the trades is not less apparent when the winds from all directions are combined in a single mean, as in Table 13.

DIURNAL VARIATION IN WIND VELOCITY AT HONOLULU

The amplitude of the diurnal variation at Honolulu in January is on the average 4.5 miles per hour and in July 6.2 miles per hour. The increase in velocity begins about 5 a. m. and reaches a maximum between 1 and 2 p. m. in January and between 2 and 3 p. m. in July. These and other details can be drawn from Figure 11.

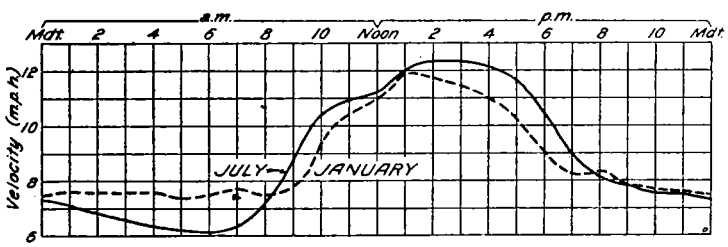

FIG. 11.—Diurnal velocity of wind, Honolulu

Tables 15, 16, and 17 have been compiled from the rather short and somewhat fragmentary records at Midway Island for Hawi Mill on the island of Hawaii (N. lat. 20° 15′ and W. long. 155° 48′), and for Guam. The elevation of the ground is 600 feet above sea level. The elevation of the anemometer above ground is not known. This station is on the windward side of Hawaii.

TABLE 15.—*Average hourly wind velocity at Midway Island*

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
1920	----	----	15.3	14.2	13.6	11.3	13.1	12.9	13.2	11.5	14.6	18.4	----
1921	17.4	20.4	16.1	18.1	11.8	10.0	17.4	11.7	14.8	16.4	14.1	17.6	----
1922	14.8	19.4	17.4	14.8	13.5	12.3	13.0	11.9	11.0	14.6	17.8	18.5	----
1923	17.2	17.2	14.9	11.2	11.2	9.6	8.7	9.1	12.3	11.9	14.7	13.0	----
1924	13.7	14.2	13.3	14.5	10.4	9.7	13.6	----	----	15.8	12.8	18.6	----
1925	11.5	15.5	14.0	18.8	19.5	11.6	12.9	9.9	9.4	10.8	13.8	----	----
Average	14.9	17.3	15.2	15.3	11.8	10.7	11.2	11.1	12.1	13.5	14.6	17.2	13.7

TABLE 16.—*Average hourly wind velocity at Hawi Mill, Hawaii*

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
1917	----	----	----	----	----	9.9	10.0	9.5	9.2	7.2	8.3	7.8
1918	6.9	9.1	7.6	7.6	8.3	8.8	11.2	9.6	8.8	10.6	9.3	12.3
1919	9.6	10.6	9.1	8.0	8.3	8.7	9.8	9.6	8.9	8.3	8.9	9.2
1920	8.0	7.1	----	8.1	10.2	15.7	14.9	14.4	14.9	11.6	14.6	13.1
1921	15.7	9.8	11.2	14.3	8.3	15.4	16.8	13.7	13.4	10.3	11.4	11.4
1922	13.1	7.5	5.0	4.3	12.5	14.2	14.7	14.9	13.0	10.6	9.4	9.1
1923	11.2	7.5	12.9	11.2	----	14.0	14.5	12.5	11.7	11.1	11.6	10.3
1924	10.1	10.9	12.3	7.8	10.4	----	15.2	12.7	9.8	12.3	8.3	10.5
1925	10.8	9.3	12.6	13.7	13.9	16.2	12.9	15.7	10.3	8.9	13.2	8.1
Average	10.7	9.0	10.1	9.4	10.3	12.9	13.3	12.5	11.1	10.1	10.6	10.2

TABLE 17.—*Average hourly wind velocity at Guam, Pacific Ocean*

[Miles per hour]

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
1920	----	----	----	----	5.8	5.7	6.8	10.7	6.1	5.0	6.0	8.5
1921	8.5	7.2	8.8	9.9	6.5	7.1	5.3	8.7	5.7	7.3	----	9.4
1922	----	----	8.4	8.5	----	----	----	6.3	6.9	5.7	7.6	8.1
1923	9.6	7.3	9.1	8.6	8.4	8.2	5.6	6.4	8.0	6.0	7.5	7.5
1924	7.6	8.5	8.8	8.1	7.6	6.7	5.9	6.4	5.6	6.3	7.0	7.1
1925	7.9	7.1	8.7	8.8	5.9	5.2	8.3	7.2	8.2	6.5	6.2	8.4
Average	8.4	7.5	8.8	8.8	6.8	6.6	6.4	7.6	6.8	6.1	6.9	8.2

WIND VELOCITIES ON SHORE AND AT SEA

During the summer when the trades are most pronounced at Honolulu, Hawi Mill, and Midway, these stations have 42, 64, and 56 per cent, respectively, of winds of force 4 Beaufort, which is estimated by seamen as the average velocity of the trades. At this season Midway is in the northern portion of the trade-wind zone and Honolulu and Hawi Mill near its center. It may be asked, What is the speed of the trades? Midway is a low, sandy, small island, and the anemometer there exposed should give very nearly true ocean velocities. (See fig. 12.)

Honolulu, as previously stated, is on the leeward side of a high range of mountains, and consequently wind velocities are less than over the ocean, but one would not suspect that they were less than half as much. Hawi Mill, on the windward side of a range of mountains, should receive nearly the full strength of the trades. The greatest velocity at the three stations here discussed is, however, that of Midway, viz, 13.7 miles per hour. That station, it will be remembered, is not at the center of the trade-wind belt. It would appear that an average of 15 to 20 miles per hour would be a fair value for the speed of the trades in the North Pacific.

SUMMARY

It has been shown that the frequency of the northeast trades at Honolulu during quite recent years has diminished concurrently with an increase in the frequency of east winds at the same station and also at Hilo on the island of Hawaii, and a cause or causes have been sought.

A consideration of the meteorological data of the west coast of North America and also of the islands of the Pacific nearest to the Hawaiian group does not lead to definite results.

A study of ships' observations in the North Pacific for the last 25 years is recommended as the most promising field of investigation that may lead to a solution of the cause of the change as above indicated.